

The University of Chicago

THE SOMATIC EFFECTS OF STIMULI
GRADED IN RESPECT TO THEIR
EXCITING CHARACTER

A PART OF A DISSERTATION SUB-
MITTED TO THE FACULTY OF THE
DIVISION OF THE BIOLOGICAL
SCIENCES IN CANDIDACY FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

1935

By
LOYD W. ROWLAND

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS

Reprinted from
JOURNAL OF EXPERIMENTAL PSYCHOLOGY
Vol. XIX, No. 5, October 1936

The University of Chicago

THE SOMATIC EFFECTS OF STIMULI
GRADED IN RESPECT TO THEIR
EXCITING CHARACTER

A PART OF A DISSERTATION SUB-
MITTED TO THE FACULTY OF THE
DIVISION OF THE BIOLOGICAL
SCIENCES IN CANDIDACY FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY
1935

By
LOYD W. ROWLAND

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS

Reprinted from
JOURNAL OF EXPERIMENTAL PSYCHOLOGY
Vol. XIX, No. 5, October 1936



THE SOMATIC EFFECTS OF STIMULI GRADED IN RESPECT TO THEIR EXCITING CHARACTER ¹

BY LOYD W. ROWLAND

University of Tulsa

INTRODUCTION

The purpose of this investigation is to study the effects of stimuli of an exciting character on certain physiological processes. The principal questions which the investigation seeks to answer may be stated in direct form as follows:

1. Will stimuli of an exciting character induce specific changes in heart rate, respiration, and the galvanic skin reflex, and will these changes be sufficient in amount to distinguish a period of stimulation from a period of non-stimulation?

2. What is the nature of the relation between quantitative variations of the exciting character of the stimuli and the amount of the induced effect?

3. Will the somatic effects increase or decrease as the stimuli are repeated from day to day, and will either the direction or amount of change vary with the strength of the stimuli?

The first task of the study was to select and grade a series of stimuli exhibiting the maximal range of exciting character. Presumably the best stimuli for this purpose are actual behavior situations in which the subject is a participant. The use of such stimuli in a laboratory experiment is obviously impracticable. This limitation was partially obviated by describing the behavior situations verbally and presenting them visually in printed form. To secure greater effect these stimuli were presented during deep hypnosis.

¹ From the Psychological Laboratory of the University of Chicago.

THE EXPERIMENT

Stimuli.—Eighty-eight behavior situations exhibiting the maximal range of exciting character were described in as many short paragraphs. These were typed on separate cards. Each described an experience which it is presumably possible for anyone to have. The paragraphs were written for men, because at the outset it was planned that the experiment would be limited to male subjects. These paragraphs (hereafter referred to as stimulus situations, items, or simply stimuli) were addressed directly to the reader and were written in the continuous present tense; that is, they all had the suggestion that the experience was continuing and that it was not yet finished.

Twenty-nine university men were asked to evaluate the stimulus situations in respect to their exciting character. These judges were instructed in the use of the psycho-physical method of *equal appearing intervals* for placing the stimulus situations along a scale. The problem was put directly to the judge as follows, "If you think a situation described would have very little or no excitement for you if you should experience it, place the card in pile 1; if you think a situation described would have the greatest possible excitement, place the card in pile 8. Place other cards on the scale according to how exciting the situations would be if you should experience them." After sorting was complete the judges were directed to go through the piles and re-examine them to make certain that all cards were satisfactorily placed.

The stimulus situations were then scaled² and the agreement of the judges on the location of each item was measured. When these measures, scale value and ambiguity, had been calculated for the 88 items, the experimenter went through the list and selected 12 for use in the experiment. Three criteria were used in the choice of these items. First, there must have been agreement among the judges on the location of an item. Hence an item too ambiguous was disposed of to begin with. The second criterion was the scale value of an item. It was desired to have items about equally spaced along the scale. In the final selection, the items had the following values: .2; 1.15; 2.05; 2.5; 3.4; 4.10; 4.35; 5.1; 5.82; 6.65; 7.65; 9. The extreme measures were found by a method of extrapolation. As a third criterion, the experimenter eliminated those items in which there appears some recurring action such as rowing a boat. In preliminary experimentation it was discovered that some subjects resort to slight imitative movements which might be expected to interfere with the functions being studied.

The 12 situations, or items, together with key number, scale value, and inter-quartile range, are given on page 549.

Use of Hypnosis.—It is perhaps important at this point to give an explanation for the use of deep hypnosis in the experiment.

In the first place, if ideational stimuli of the kind previously described are given to subjects in a normal waking state they respond with a slight altering of somatic processes; there may be no detectable change. Certainly the magnitude of the response is by no means as great as in the actual behavior situation. In hypnosis, however, when the same stimuli are given, the effects are very pronounced. While the intensity of reaction may not be as great as in a behavior situation, it seems to approach that level of response.

A second and perhaps less vital reason for the use of hypnosis is the effectiveness of that technique in eliminating distractions in the sensory field and in the form of competing ideas. The usefulness of hypnosis is attested by Heilig and Hoff (11) who say that hypnosis "eliminates all spontaneous processes in consciousness," that "consciousness is limited to the idea-content given by the hypnotist."

² According to the method of L. L. Thurstone (14).

Key Number	Item	Scale Value	Inter-quartile Range
72	You are driving along a country road and come in sight of a flock of sheep grazing in a meadow. You stop and watch them. Some of them raise their heads and look at you.	.20	2.50
31	You are sitting in a formal garden on a stone bench alone watching a fountain spraying.	1.15	1.60
85	You are standing watching a sailor being tattooed. He is having an anchor tattooed on his arm.	2.05	1.95
49	You are witnessing a magnificent display of fireworks on the night of the Fourth of July.	2.50	1.25
61	You are standing so you can observe a seismograph. You see the swings of the instrument, and you know that an earthquake is going on somewhere.	3.40	1.50
26	You have cut your hand and there is a slow flow of blood that will not stop. Someone sends for a doctor, but he has not yet come.	4.10	1.50
3	You catch a woman in the act of stealing a pair of shoes. She is begging you not to report her to the police, saying that her children have no shoes. You doubt her story and keep an eye on her. She slips out of the store and down the street.	4.35	2.05
50	You are a dinner guest in the home of some people whom you don't know very well. You knock over a glass of water.	5.10	2.00
8	It is a very formal party and a friend has just informed you that you have a long rip in the seat of your trousers. You wonder how many people have seen it and spend your time trying to see that you are not further discovered.	5.85	1.60
79	You have been lowered one hundred feet below the surface of the ocean in an observation tube and are in no danger. In the clear water you can see a whale in battle with two large swordfish. It is a terrific battle. You keep watching.	6.65	1.70
66	You find yourself going down in quicksand when you try to cross a dry stream. You are successful after a hard fight in extricating yourself.	7.65	1.90
77	You are in Africa alone, when suddenly you are attacked by a leopard. You shoot and disable him, but he comes after you and you keep defending yourself with the bayonet on the end of your gun.	9.00	2.00

A third advantage in the use of hypnosis is that skeletal responses can be inhibited, while the more involuntary somatic processes, which this investigation purports to study, continue uninhibited. The presence of skeletal responses complicates the problem of measuring somatic responses and their elimination is of great practical importance to the experimenter.

The use of hypnosis raises the following question: Will our experimental findings be limited to the hypnotic condition, or will our empirical answers to the three proposed questions also be applicable to the waking state? There is no decisive evidence on which to base a judgment. In the absence of such evidence, this study assumes that these exciting stimuli will arouse essentially the same *kind* of somatic response for the two conditions although the amount of the response may differ materially for the two cases. Consequently we shall assume that the relation between the two variables studied will be essentially the same in character for both the hypnotic and the waking states.

Subjects.—The next problem was to find subjects who would go into deep hypnosis, upon whom the stimuli might be applied. Thirty-two subjects were examined in an

effort to find those suitable, *i.e.*, those who would go into a sleep sufficiently deep for the experiment. Out of the thirty-two, four went into a very deep sleep. It is with these four subjects that the experiment here reported is concerned.

Apparatus.—The measurements taken were concerned with changes in pulse rate, in respiration, and in the galvanic skin reflex. All recordings were made simultaneously on a photographic strip. Pulse rate was taken by means of an inflated cuff wrapped about the ankle. Only enough air pressure was kept in the cuff to show heart beats clearly on the developed film. Thus the subject could sit for a long period without the discomfort that comes with too much interference with circulation. A pneumograph was fastened about the chest to indicate changes in respiration. A string galvanometer was used to show changes in the electrical resistance of the skin. The instrument used in the present study was modified in accordance with the hook-up of Darrow (9). The advantages of the arrangement have been enumerated by him.

The electrodes of the galvanometer were zinc with a coating of a paste of kaolin powder and zinc sulphate solution. One of the electrodes was applied to the palm of the hand and the other to the back; they seemed to work satisfactorily. The string came quickly into balance and did not require frequent adjustment due to chemical and thermal changes in the electrodes. During a part of the experiment one of the electrodes was applied to an area rendered indifferent either by the use of iodine or by pricking the skin, but this practice was discontinued. The iodine was found to be an irritant in connection with the zinc sulphate-kaolin paste and pricking the skin repeatedly with a needle was unsatisfactory.

A kymograph of the camera type was used for taking records. An electric motor fed a strip of bromide paper past the lens of the camera at a very slow rate, approximately six inches per minute. The lamp back of the string in the galvanometer cast a shadow of the string against the aperture of the camera and at the same time furnished enough light to expose the film. Shadows from the pointers of pulse and respiration tamborus were simultaneously cast on the film along with that of the string of the galvanometer. A metronome interrupted the source of light every second making a time line on the record. Minute markings across the lens of the camera caused millimeter lines to appear lengthwise of the developed film strip.

Procedure.—The subjects were hypnotized in a room adjacent to the experimental room. Preliminary work showed that persons who first saw the experimental room could not be hypnotized. The forbidding appearance of the apparatus was no doubt largely responsible. After deep hypnosis had been induced the subject was asked to move into the experimental room and be seated at a table.

The hypnotized subject next memorized the twelve stimulus cards. He was checked by the experimenter from time to time during the experiment to see that all essential points were retained.

While each stimulus was being memorized, a substitute card with the stimulus shortened to a phrase was also exposed. The shortened cards only were used subsequently. By this means the stimulus could be presented quickly. Preliminary experimentation showed that when the original stimulus cards were used, bodily changes got under way before the reading of the card was finished.

The subject was now ready to begin the first day's experimentation. The apparatus was attached. When adjustments were complete the subject was told to fall into a much deeper sleep and was given a period of time to quiet down. Subjects were told to avoid movements of the arms and legs. They were told further that if the apparatus caused pain, this fact was to be reported promptly.

Each of the 12 stimuli was given once at each sitting. The order of presentation of the 12 stimuli was varied systematically from day to day. There were 12 stimuli, and hence 12 positions in which they might be placed. An effort was made to perfect a plan whereby each stimulus had occupied each position by the time the experiment was complete for any one subject. For example, in arrangement *a*, stimulus 49 was in the 4th position; in arrangement *b*, the 8th position; in *c*, the 2nd, and so on. A perfect plan whereby each stimulus occupies each position is not possible when there are 12 stimuli and 10 days of experimentation.

Each subject began the experiment with a different arrangement and took the remaining ones in order. Thus the first subject began with arrangement *a* and continued through *j*. The next subject began with arrangement *b*, continued through *j* and ended with *a*.

When any experimental day began the subject was told that he was about to be shown the short stimulus cards again. He was told that he would actually *have* the experiences described. The statement was emphasized that these experiences would be 'very vivid, very real.' This exact terminology was used consistently.

The subject was told that the experience would continue for 30 seconds, or until a signal from the experimenter. As the technique of presentation of the stimuli was finally worked out the subject sat with eyes closed except for the moment when it was necessary for him to open them in order to see the words on the short card. This procedure was followed because it is known that the galvanic skin reflex is closely associated with motor behavior, and by the means indicated, the amount of muscular effort in receiving the stimuli was reduced to a minimum. It was necessary simply to open the eyes, and having perceived one line on the card, to close them again. The only words spoken by the experimenter after the presentation of the first stimulus card were, "The first card, please" (later, "The next card, please"), and, at the end of 30 seconds, "That will be all."³

A rest period of 30 seconds was introduced between stimuli. No records of somatic changes during the rest periods were taken. The experimenter observed that during these periods there was almost no change in galvanic skin activity. Respiration was very regular.

Records for four 30 second periods of non-stimulation were taken each day as a standard of reference. One of these was taken each day before any of the stimuli had been given, and one after all stimuli had been given. The subject was not aware that these two records were being made. The other two were interspersed among the stimuli and their location was varied from day to day. For these two the subject opened his eyes, saw the word 'Blank' on a card, and closed them again. He had been instructed that when this happened he was to have simply no experience.

Tests were repeated for ten days.⁴ The 12 stimuli were given twice to two subjects on three days. This was done as a convenience to these subjects who had to come a considerable distance to take part in the experiment.

³ After the experimental period was complete, subjects were told to "Let these experiences slip from your mind and think of them no more." They were given the usual suggestions about feeling well and absence of eye strain. They were usually awakened in the experimental room.

⁴ When the subject had completed the ten days of experimentation he was tested to see how much of the experiences through which he had gone had been retained. The depth of hypnosis in which the subjects had been may be inferred from the fact that all of them had to relearn the stimulus paragraphs in the waking state. They did not recall having seen the cards before.

Number of Records Available.—At the close of an experimental day, 16 half-minute records had been taken. For subjects who completed ten days of experimentation there were therefore 160 such records available, or 640 for four subjects. According to the plan there were 40 records for each stimulus because all four subjects were given each stimulus on ten occasions. Thus each value for each stimulus was the average of 40 measures; the standard (period of non-stimulation) was an average of 160 measures.

Actually, however, the number of records taken was less than 640, for the following reasons: (1) One subject was able to complete but seven days of experimentation. (2) There was an occasional loss of a record due to failure of the camera to feed the film properly. (3) Two film strips, each containing 16 records and each the work of one day's experimentation, were lost by overdeveloping. These, unfortunately, represented the first day's work with two subjects. (4) Two subjects were asked to go through the experimental series in the waking state. They had just finished their day's experimentation while hypnotized and were very sleepy. While supposedly awake, they seemed to fall back into a light hypnotic trance, and the experimenter was so uncertain of their exact state that he could not use the records.

In spite of the losses, there were retained 518 records. Records were measured in 8 different ways. Descriptions of these measures will be given later.

Results.—There was one measure each for pulse and the galvanic skin reflex. For respiration, however, the records admitted of a greater number of analyses and were accordingly studied in six different ways. Descriptions of the various measures will be given wherever the names are not self-explanatory.

The numerical data are given in Table I. In the first row are found the scale values for the various stimuli. Below these are the corresponding values for each of

TABLE I
AVERAGE EFFECT OF STIMULI

Measure	Stand- ard	Scale Value											
		.2	1.15	2.05	2.50	3.40	4.10	4.35	5.10	5.85	6.65	7.65	9.00
Pulse . . .	78.4	81.4	81.1	83.3	83.9	81.7	83.5	82.8	83.9	84.6	85.0	85.9	85.4
Galvanic skin reflex	.8	2.3	2.6	4.7	3.6	3.4	3.5	3.0	3.4	4.0	3.9	6.1	6.1
Respira- tion													
A.	18.2	19.0	18.0	20.6	20.6	21.9	21.2	19.8	20.5	22.3	22.7	21.9	21.6
B.	35.0	45.8	50.6	49.7	61.4	53.0	53.4	55.8	54.6	57.4	70.0	80.4	80.4
C.	.53	.64	.61	.63	.68	.71	.68	.66	.68	.70	.74	.76	.75
D.	5.35	7.65	7.80	7.25	8.98	7.23	7.87	8.25	7.47	7.97	9.96	11.4	11.0
E.	.66	1.38	2.21	1.93	2.35	1.39	2.26	2.17	1.96	1.99	2.70	3.73	3.32
F.	.69	1.51	1.75	2.34	2.78	1.71	2.45	2.58	2.45	2.42	3.14	4.35	3.73

the eight measures. The 'standard measure of non-stimulation' for each of the eight measures is given in the first column. These values will be referred to hereafter as the standard. Each of the values in the table is the average for all subjects for all experimental days. These data furnish the answer to questions one and two as stated in the Introduction.

In order to study the effects of stimulus repetition, the data for those days for which there were complete records were grouped temporally into two series. Experimental days 2, 3, and 4 compose the first series, and days 5, 6, and 7 compose the second series. Figure 1 shows these two series plotted for each measure. The large circles

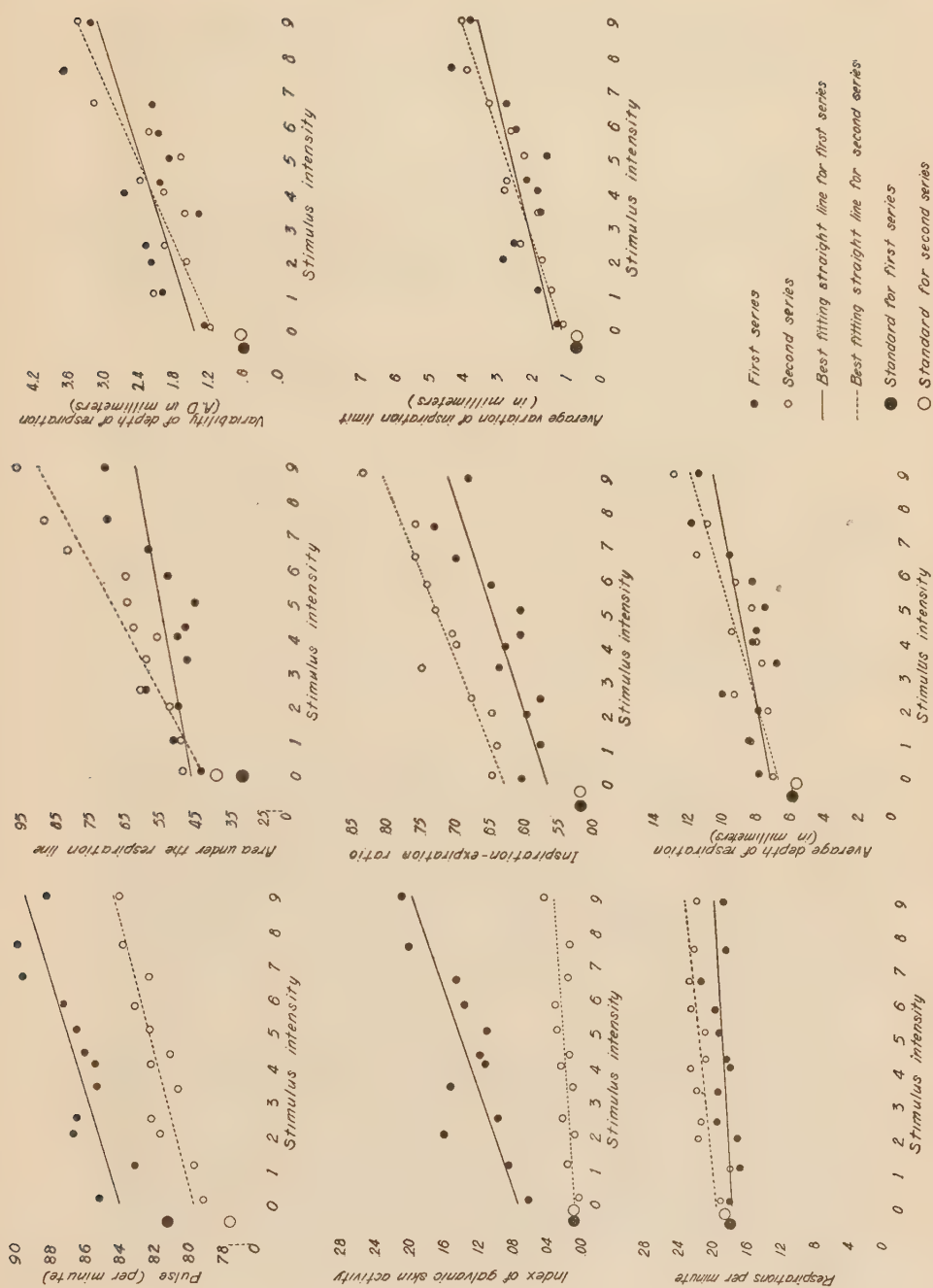


FIG. 1. Showing the effects of stimulus repetition.

denote the standard values, and the small circles represent the values for the various exciting stimuli. The black circles represent the values of the first series, and the open circles the values of the second series. The lines shown are the straight lines of best fit.⁵ The difference in size of the two series of values represents the effect of repetition.

1. *Pulse*.—Each of the exciting stimuli increased the heart rate in comparison with the standard (Table I). (This statement is also applicable to each of the four subjects with the exception of one stimulus for one subject.) The increase ranged from 2.7 to 7.5 beats per minute. Corresponding percentage values are 3.4 and 10.

The rate tended to increase with the strength of the exciting stimulus, and the relation between the two variables is approximately linear in character.

The effect of repetition is a decrease in heart rate and this occurs throughout the scale. (See Fig. 1.) The average heart rate for the stimuli of series one is higher by 4.8 beats per minute than for series two. The standard for series one is higher by 3.5 beats per minute than for series two. The slope of the best fitting straight line is slightly greater for series one than for series two, the numbers being .34 and .30 respectively.

The findings here reported are in substantial agreement with the early work of Angell and Thompson (1) who, on the basis of their own work and that of others, conclude that increase in heart rate is associated with increase in mental activity. The recent review of Darrow (7) concludes that an increase in heart rate is to be expected from long sustained ideational stimulation. Dodge (10) found an increase in pulse rate related to an increase in excitement in an actual behavior situation.

2. *Galvanic Skin Reflex*.—Measures used in the investigation of changes in the galvanic skin reflex took into consideration the initial resistance of the subject at the time the stimulus was applied. Brown (4), Cattell (6), Darrow (8), and Lauer (13) have used this percentage measure, the denominator being the resistance of the subject at the time

⁵ Fitted by the method of least squares in such a way that errors in the y-axis are minimized.

of the application of the stimulus, and the numerator being the amount of change in resistance in response to stimulation. Thus, a subject who shows a high resistance at one time may be expected to respond to stimulation with a greater change in resistance than when his resistance is lower. All measures in the study were of this character. These measures have been multiplied by 100 to accord with current practice in dealing with this index of galvanic skin activity.

The averages for all subjects for each stimulus are given in Table I. All of the exciting stimuli increased the measure in comparison with the standard. The same statement is true of each of the four subjects with the exception of one stimulus for one subject. The increase ranged from 1.5 to 5.3. Corresponding percentage values are 187 and 663.

Values tended to increase with the strength of the stimuli; the relationship is non-linear. Two of the most exciting stimuli elicited unusually strong reactions.

There is no change in the standard with repetition (Fig. 1); there is, however, a pronounced change for the exciting stimuli. The degree of change increases with the strength of the stimulus, and may be said to be highly specific, and not general as in the case of heart rate.

The galvanic skin reflex has almost disappeared in the second series and the slope of the line of best fit is so slight that it differentiates poorly between the more and the less exciting stimuli.

3. *Respiration*.—The respiration curves were studied in many different ways. First of all, counts were made of the number of respirations per minute (Table I, line A).

A second measure was the area under the respiration curve (line B of Table I). This measure was taken by the following method: Considering the points on the record where expiration stopped as a base, a polar planimeter was used to measure the area under the curve. This was done with considerable accuracy, so that even though the size of the photographic record was small, a retracing of the irregular surface revealed a discrepancy which amounted to but 1 to 2 percent of the

total area. Values were in square inches. All numbers were multiplied by 100 for convenience in handling.

A third measure was concerned with the length of inspiration time as compared with the length of expiration time. The former divided by the latter gives the so-called inspiration-expiration ratio (line C).

As a fourth measure, the average depth of respiration was computed (line E).

For a fifth measure, the variability of depth of respiration was computed (line E). To do this it was necessary to get the average deviation for each record for each subject for each day. The average of these gave an index of the variation in height of the respiration curve.

The sixth measure of respiration was concerned with variation of the inspiration limit. The term 'inspiration limit' refers to the point on the record where inspiration ceases and expiration begins. The altitude of this point varies for successive respirations during excitement and the measure here used is the average difference in successive points during the application of a particular stimulus. The measure has been used effectively by Bass (2).

A. Number of Respirations per Minute.—In this measure (Table I, line A) eleven of the twelve stimuli showed an increase over the standard. (This was the case also with 43 of the 48 individual records.) The range was from .2 less than the standard to 4.5 greater. Corresponding percentage figures are —1 and 25.

There was a slight increase in the measure as the strength of the stimulus was increased. The relationship is approximately linear.

Repetition tends to increase the number of respirations per minute. This is true for all stimuli, and, in general, the more exciting the stimulus the greater the increase. The standard is slightly increased also, but there is a greater increase for the stimuli. The explanation of these increases is probably that as the experiment progressed there was less restriction on respiration, and consequently fewer occasions when the breath was held for short periods. In the computations no account was taken of these 'holds.'

B. Area under the Respiration Line.—This measure shows an increase above the standard for all stimuli (Table I, line B). (There is a similar increase also for all individuals.) The range is from 10.8 to 45.4. Corresponding percentage figures are 31 and 129.

Values tend to vary directly with the strength of the stimuli, though the relation is non-linear. There are relatively smaller increments for the stimuli near the center of the scale and relatively greater increments for the more exciting stimuli at the upper end of the scale.

Repetition tends to increase the area under the respiration line. This is the case for the standard and for eleven of the twelve stimuli. There is a strong tendency for the increases to be proportional to the strength of the stimuli.

C. Inspiration-expiration Ratio.—This measure has been studied chiefly by those who were interested in its use as an indicator of deception.⁶ It is probably true that all cases of deception are exciting, and that the greater the deception the greater the excitement. It seemed possible that all exciting situations might be accompanied by a change in the ratio, and for that reason it was introduced here.

The results from the measure are shown in Table I, line C. It will be observed that the standard is .53. All stimuli caused an increase over the standard and this was true of all individual results as well. The range of increase over the standard was from .08 to .23. Corresponding percentages are 15 and 43.4.

The ratio increases with the strength of the stimuli, and the relationship is by inspection linear.

Repetition does not affect the standard, but results in an increase for all of the stimuli. The straight lines of best fit for the two series are almost parallel; there is a slight tendency for the stimuli at the upper end of the scale to cause a greater ratio in the second series.

D. Average Depth of Respiration.—The change in average depth of respiration with increase in stimulus intensity is seen in Table I, line D. The standard is 5.35; and all stimuli show increases over this amount. (Individual results also show

⁶ See Benussi (3) Burt (5), and Landis and Gullette (12).

this to be true in 47 out of 48 cases.) The range of increase is from 1.88 to 6.05. Corresponding percentages are 35 and 113.

There is a tendency for depth of respiration to increase with stimulus intensity, though the results are not proportional.

Repetition has but a small effect on the standard, diminishing it slightly in the second series. With repetition there is a tendency for the values to decrease for the less exciting stimuli and to increase for the more exciting ones. For the first series the slope is .18, and for the second it is .28.

E. Variability of Depth of Respiration.—The results of the computations for this measure appear in Table I, line E. All stimuli cause an increase over the standard; this statement is true also for 47 of the 48 individual results. The range of increase is from .72 to 3.07. Corresponding percentages are 109 and 465.

There is a clear indication that as intensity of stimulus increases there is a corresponding increase in irregularity of depth of respiration. However, the relationship between these variables is not proportional.

The effects of repetition are not clear. The standard remains about the same. As the stimuli are repeated variability is decreased for the less exciting stimuli and increased for the more exciting stimuli. The slopes of the straight lines of best fit are .30 and .42 for the first and second series respectively.

F. Average Variation of Inspiration Limit.—All stimuli show an increase over the standard which is .69. The range is from .82 to 3.66, the percentage figures being 119 and 530.

There is a tendency for this measure to increase with the strength of the stimuli, and the line of best fit is a straight line. Six of the twelve points on the graph fall very close to the line.

Repetition does not affect the standard; it affects the stimuli only slightly. Seven of the eight most exciting stimuli are increased and the four least exciting are decreased. The slopes are .24 and .31 for series one and two respectively.

CONCLUSIONS

From the foregoing results it seems possible to draw the following conclusions:

1. Heart rate, the galvanic skin reflex, and the six measures of respiration are increased by exciting ideational stimuli during hypnosis. The application of even the least exciting stimulus gives effects which are clearly distinguishable from that of a period of non-stimulation.

2. The increase in effect is roughly proportional to the strength of the exciting stimulus. In some cases the relationship is linear, but in others, due particularly to the pronounced effect of the more exciting stimuli, it is non-linear.

3. As the stimuli are repeated, heart rate is decreased and the decrease is about the same throughout the scale; there is also a corresponding decrease in the standard. Respirations per minute and inspiration-expiration ratio by contrast are increased, and the increase is approximately the same throughout the scale. The standard for these, however, remains unchanged. There is a decrease in galvanic skin activity and the decrease is proportional to the strength of the stimulus. Again by contrast, there is an increase in area under the respiration line and the increase is proportional to the strength of the stimulus. The other measures show a decrease in the effectiveness of the less exciting stimuli and an increase in the more exciting. All standards remain unchanged for these measures.

With the repetition of stimuli there is an indication that the processes studied become less variable. The residuals of the straight lines of best fit (Fig. 1) were computed for all measures and it was found that they are much less for the second series than for the first. The ratios of the first to the second for each measure are as follows: pulse, .56; galvanic skin reflex, .39; respirations per minute, 1.04; increase in area under the respiration curve, .82; inspiration-expiration ratio, .58; average depth of respiration, .80; variability of depth of respiration, .76, and average variation in inspiration limit, .46. The average ratio is .68, which means that residuals are on the average but two-thirds as great in the second series as in the first. This decrease of variability is probably due to the disappearance of 'general excitement,' and the arousal of more specific responses to the stimuli.

The writer is greatly indebted to Professor Harvey A. Carr for supervision of the problem from the beginning, but especially for help in the final preparation of the manuscript. Professor L. L. Thurstone gave advice on methods and made suggestions about the measures to be used. Dr. C. W. Darrow very greatly helped with the apparatus; he built a special bridge of his own design and installed it in the galvanometer, and from time to time assisted when difficulties were encountered.

(Manuscript received October 22, 1935)

REFERENCES

1. ANGELL, J. R. AND THOMPSON, H. B., The relations between certain organic processes and consciousness, *Psychol. Rev.*, 1899, **6**, 32-69.
2. BASS, M. J., Differentiation of the hypnotic trance from normal sleep, *J. Exper. Psychol.*, 1931, **14**, 382-399.
3. BENUSSI, V., Die Atmungssymptome der Lüge, *Arch. f. d. ges. Psychol.*, 1914, **31**, 244-273.
4. BROWN, W. S., A note on the psycho-galvanic reflex considered in conjunction with estimates of character qualities, *Brit. J. Psychol. (gen. sec.)*, 1925-26, **16**, 130-135.
5. BURTT, H. E., The inspiration-expiration ratio during truth and falsehood, *J. Exper. Psychol.*, 1921, **4**, 1-23.
6. CATTELL, R. B., Experiments on the psychological correlate of the psycho-galvanic reflex, *Brit. J. Psychol. (gen. sec.)*, 1929, **19**, 357-386.
7. DARROW, C. W., Differences in the physiological reactions to sensory and ideational stimuli, *Psychol. Bull.*, 1929, **26**, 185-201.
8. —, The relation of the galvanic skin reflex recovery curve to reactivity, resistance level, and perspiration, *J. Gen. Psychol.*, 1932, **7**, 261-273.
9. —, Uniform current for continuous standard unit resistance records, *J. Gen. Psychol.*, 1932, **6**, 471-473.
10. DODGE, R., Mental work. A study in psycho-dynamics, *Psychol. Rev.*, 1913, **20**, 1-42.
11. HEILIG, R. AND HOFF, H., Psychische Beeinflussung von Organfunktion, insbesondere in der Hypnose. Sammelreferat. *Allgem. ärztl. Z. f. Psychother. u. Psych. Hygiene*, 1928, **1**, 268-279.
12. LANDIS, C. AND GULLETTE, R., Studies of emotional reactions. III. Systolic blood pressure and inspiration-expiration ratios, *J. Comp. Psychol.*, 1925, **5**, 221-253.
13. LAUER, A. R., Reliability of the galvanic reflex, *Amer. J. Psychol.*, 1929, **41**, 263-270.
14. THURSTONE, L. L. AND CHAVE, E. J., *The measurement of attitude*. Chicago: Univ. of Chicago Press. 1929.

LANCASTER PRESS, INC., LANCASTER, PA.